

**TIME CRITICAL STRIKE AND FIRES
FLEET BATTLE EXPERIMENT RESULTS
SUMMARY REPORT**



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All of the Fleet Battle Experiments to date have included time-critical target related experimentation. This report summarizes the more important results obtained to date. These results have hardware, software, organization, personnel, and program implications.

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1. INTRODUCTION

Time Critical Strike and Fires, in various forms, has been a topic of investigation in every Fleet Battle Experiment. It refers to the melding of heretofore stove-piped processes. Initially, strike aircraft, gun fire, cruise missiles, etc, are all assigned to prosecute targets within the same detection to engagement process. Within the Time Critical Strike and Fires process, those targets which are time-critical can be fixed, re-locatable, or mobile. They may be pre-designated and assigned within the deliberate planning cycle, or they may be previously unidentified targets that “emerge” during an operation. It is possible that the status of previously identified targets will become time-critical, such as identification that an area is being used to prepare TBMs with mass destruction capabilities. A Transporter, Erector, Launcher could be a high priority Time Critical Target when a missile is elevated and ready to fire and be a routine target when it is in another phase of its operational cycle.

Time criticality can mean that targets require immediate engagement or that a target is to be destroyed by a particular time. Thus, the actual time from detect to engage can vary from days to minutes, depending on the imminence of danger, the operations of the target, current U.S. operations and requirements, the opportunity cost of immediate engagement, and a complex set of priorities and probabilities of success.

The results presented in this report represent observations garnered from FBE-Alfa (September 1997) through FBE-Golf (April 2000). TCT prosecution has been a feature of each FBE. An original fires concept known as “Ring of Fire” has evolved into Poseidon’s Fury, which focuses on applying the NCO principles of decentralization, Effects Based Operations (EBO), and self-synchronization to targeting both deliberate and time sensitive targets.

The format in which these results are presented replicates a possible net-reporting system where one enters the system at high-level results then drills down to increasingly detailed information. Thus, the results are in three sections:

- Summary Results,
- High Priority Results, and
- Results and Implications.

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2. FLEET BATTLE EXPERIMENTS SUMMARY RESULTS

SENSOR MANAGEMENT AND NUMBERS

Engaging time critical targets, over an extended battlespace, in an asymmetric environment, requires a significant increase in numbers of tactical sensors. Centralized management of sensors through an ISR Desk has been shown to be beneficial, but there are latency issues. Coordinated control of both the locations of sensors over the battlespace and of information processing and distribution of processed sensor information is required. A Common Sensor Picture (CSP) will be required if sensor management is to be distributed and coordinated.

FLATTENED COMMAND AND CONTROL

Meeting rapid-engagement timelines requires a flattened C2 structure. Requirements for this to work are shared situational awareness, Commander's confidence in the actions of subordinates and in the progress of the engagement, and clearly articulated and understood Commander's intent. Recent advances in the Common Operations Picture show that these requirements can be met but that considerable development remains to be done. Tested flattened C2 structures have reduced time critical target timelines.

WEAPON MIX

Navy roles in the littoral require a mix of weapons and targeting capabilities. Experiments clearly show a tendency to use the most capable weapon available for all circumstances. The available numbers of these weapons will not support such use. An inventory of advanced weapons, with a mix of accuracy, speed, lethality, area coverage, range, numbers, and logistics support needs to be developed. New TTPs for coordinating sensor management and a robust weapons mix are needed. Long range weapons than can be used in area fire for suppression, and the accompanying TTP, has emerged as a needed capability when long standoff range is necessary in early phases of access operations.

COMMON TACTICAL PICTURE AND BANDWIDTH

The flattened C2 structure relies heavily on a common tactical picture available at all nodes of the operation. Experimentation shows that it will be possible to develop and distribute the CTP within the latency times of current fires management systems. Information overload at decision nodes results if all information is available everywhere, and further work is needed to determine who gets what information when and at what refresh rates. Increased bandwidth and sophisticated bandwidth management will be needed for full implementation of the CTP.

ORGANIZATION AND ROLES

Navy organizations and processes need not mirror joint organizations such as JFACC but must be capable of performing the key functions and be adaptable to joint operations as the theater matures. In order to provide short latency, the targeting function for TCT will need direct imagery support and control. A Fires element with supporting networks and TTP may be a key doctrine. Such an element must have considerable authority in the C2 network. The complexity of the environment and increased responsibility given to operators in a flattened C2 structure will require new organizational roles and operators with new skill sets. In order to manage the Network Centric information system, four generic position types have been identified: Sensor Manager, Network Manager, Information Manager, and COP/CTP Manager.

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3. FLEET BATTLE EXPERIMENT HIGH PRIORITY RESULTS

The following list of high priority outcomes related to Time Critical Strike and Fires (TCSF) is further described in more detail in the last section of this report.

These results are outcomes of the requirement for a naval access mission in the littorals, and are grouped into five principal areas.

From a larger, overriding and system perspective, TCSF requires a sensor system that covers the tactical area in time and space, has a rapid responsive detect-decide-engage and assess process, provides relevant information from a common database at all decision nodes in the process, incorporates dynamic commander's intent, and has shared situational awareness.

3.1 DEPTH AND MANAGEMENT OF THE SENSOR GRID

An increase in sensor numbers is required to maintain continuous coverage of the battlespace.

Increased sensor density requires improved sensor grid management. Data shows that centralized sensor *management* can create bottlenecks (in particular around mensuration of sensor data to create aim points). Some centralized *processing* must occur however, so that data fusion capabilities are not simultaneously required on all platforms.

Sensor management is most efficient when it promotes coordination between platforms and their organic sensors, and made part of SA in the COP. In this case, it will be necessary for platforms to share data and coordinate, implying an increasingly robust data and information system for shared situational awareness.

A sensor COP, managed in parallel with (or as part of) a situational awareness COP, is required. The structure of the SA COP is closely coupled to the structure of the TCSF C2 system.

Sensor platforms need multi-sensor capability, which reduces the sensor management problem by allowing flexibility in their employment in the TCSF environment.

Assessment is a sensor mission, and adds to the requirement for increased sensor coverage by increasing sensor numbers, and increased bandwidth for expanded data.

3.2 DECREASING THE TCSF TIMELINE REQUIRES A FLATTENED C2 STRUCTURE

In an increased information management environment, flattening levels of organization decision hierarchies is necessary in order to ensure TCSF timeline speed inside of TCT dwell times.

Flattened C2 structures also means that all required information is available to all users all the time—bandwidth is imperative. Bandwidth availability is also increased by improved network management through use of real-time network control tools, and by efficient usage through information management. Reachback to CONUS is a necessary capability requiring on-demand bandwidth. Adequate on-demand bandwidth for reachback provides capability for decision making to reside in theater of operations, vice CONUS. Additional experimentation is required to understand tradeoff between obtaining bandwidth for reachback to technical capabilities (e.g., CMSA) vice reproducing these capabilities forward in theater (and thus reducing bandwidth requirements).

3.3 COMMON TACTICAL PICTURE AND BANDWIDTH

A flattened C2 structure emerges simultaneously with an effective common operational picture (COP). The COP becomes a Common Tactical Picture (CTP) as a common data stream from which tailored situational awareness for tactical purposes is constructed, and changes with developments in the battlespace.

Producing a CTP requires standard data structure throughout the battlespace and between all organizations and processes joined in the CTP, whether for tactical use or for situational awareness. Stove-piped processes within systems that are data-unique will require transformation to standard data structure elsewhere in the network centric data grid, producing latencies and decreasing TCSF capability.

3.4 WEAPON RESOURCE MANAGEMENT

The correct weapon, employed in time and for a desired effect requires that a mix of weapon types be available. Current weapons mix and TTP do not provide adequate effects potential, and are not in sufficient quantities to provide a reserve as the Navy conducts littoral access in an asymmetric environment.

Often, weapons are considered employable based on singular qualities of system range, speed, accuracy and availability. In a network centric environment, these qualities *together* must define weapon employment. Balancing these elements of *system* performance requires higher order weapons systems-target pairing for effects management. These elements of a *weapon system* must also conform to system management of sensor capabilities, target type and dwell time, sensor data processing, weapon employment capabilities and weapon platform location and system status.

3.5 ORGANIZATION IMPLICATIONS IN NETWORK-CENTRIC OPERATIONS

The Joint Interoperability and Control Officer (JICO) model needs to be expanded to include a Network Control Officer (NCO).

The COP/CTP will require separate management by a COP-C officer.

Enhanced distributed collaborative tools will increase in importance, producing a need to deal with issues of span of control; traditional command relationships to subordinate components will be challenged by distributed and flattened C2.

Organization processes for conducting TCSF are separate from deliberate target planning cycles, but often share portions of the same resources that are included in deliberate planning. TCSF and deliberate planning need to be synchronized, but not interdependent. In this case 4D deconfliction is an issue and must be included as part of the COP.

As the Navy transitions from access to support of follow on forces, MCC TCSF processes must be easily included in JFACC and JFMCC structure.

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4. FLEET BATTLE EXPERIMENT RESULTS AND IMPLICATIONS

4.1 NAVY IN THE LITTORAL

Access assurance is a core Navy mission. The Navy's blue water and power projection capabilities are unchallenged, thus opponents will attempt to deny access to the littorals with asymmetric applications of force to areas of perceived U.S. weakness. They will have available increasingly sophisticated weapons systems and use them in ways that reduce the time US forces have to react, such as coastal defense cruise missiles and mobile theater ballistic missiles (TBMs). Enemy tactics will be designed to limit their exposure to our weapons and sensors. Combating this asymmetric threat will require the capability to find, target, and rapidly engage a wide range of enemy forces with surface, subsurface, and air-launched weapons. In future scenarios, it is likely that the Navy will be required to establish conditions to allow operational-level movement and maneuver of a joint force into a hostile theater. In this report we address only the fires support against time critical targets requirement to accomplish the Navy in the littoral mission.

4.2 TIME CRITICAL STRIKE AND FIRES

Time Critical Strike and Fires (TCSF) refers to the melding of heretofore stove-piped processes. Initially, strike aircraft, gun fire, cruise missiles, etc, are all assigned to prosecute targets within the same detection to engagement process. Within the TCSF process, those targets which are time-critical can be fixed, re-locatable, or mobile. They may be pre-designated and assigned within the deliberate planning cycle, or they may be previously unidentified targets that "emerge" during an operation. It is possible that the status of previously identified targets will become time-critical, such as identification that an area is being used to prepare TBMs with mass destruction capabilities. A Transporter, Erector, Launcher (TEL) could be a high priority Time Critical Target (TCT) when a missile is elevated and ready to fire and be a routine target when it is in another phase of its operational cycle.

In the TCSF process, time criticality can mean that targets require immediate engagement or that a target is to be destroyed by a particular time. Thus, the actual time from detect to engage can vary from days to minutes, depending on the imminence of danger, the operations of the target, current U.S. operations and requirements, the opportunity cost of immediate engagement, and a complex set of priorities and probabilities of success.

The following elements are requirements for a successful TCSF process:

- Sensor system that covers the tactical area in time and space
- Command and control organizations that distributes responsibilities and is adaptable
- Shared situational awareness
- Rapid Detect-Decide-Engage-Battle Damage Assessment process
- Common information at all decision nodes in the process
- Dynamic commander's intent and rules of engagement

4.3 NETWORK CENTRIC OPERATIONS, AN ENABLER

Though faced with increasing difficult challenges in the littoral, advances in information technology introduce the possibility of near real-time engagement of critical targets. Network Centric Operations (NCO) are based on the dynamic networking of sensors, weapons, and decision nodes. The goal is to reach a new state of information superiority, shared awareness, adaptability, speed of command, and self-synchronization. For TCSF, Fleet Battle Experiments (FBEs) have focused on developing organizational structures and processes, supported by new networked information systems, in order to gain insight into the enabling requirements and necessary capabilities for NCO support of TCSF.

Reduction of the decision timeline, the period between initial detection and weapons release, offers perhaps the greatest opportunity to expedite the “detect to engage” (DTE) process. Current thinking is that decentralized, distributed operations will speed the execution of TCSF and much of experimentation to date has been to test this concept and how to execute it. The following are the elements that have been tested:

- Flattening the Command and Control structure
- Use of collaborative tools
- Characteristics of and use of a common data system

4.4 FLEET BATTLE EXPERIMENTS

FBEs are a CNO-initiated series of experiments designed for the purpose of “operationalizing” NCO and developing supporting concepts through the co-evolution of new doctrines, organizations, and technologies. The Maritime Battle Center (MBC) of the Navy Warfare Development Command (NWDC) is the CNO’s agent for planning and implementing these experiments in partnership with the numbered fleets. The experiments are directed at the operational level of war and the methodology closely resembles that of a case study.

FBEs are loosely scripted and event-driven, focusing on complex interactions among commanders, operators, and their supporting technologies. They follow an iterative process and the results presented here for TCSF show the current accumulated results. These results point to both programmatic and policy requirements. Future experimentation will further define these results.

4.5 FLEET BATTLE EXPERIMENT RESULTS

In Time Critical Strike and Fires (TCSF), MBC has focused on developing alternative organizational structures and processes in order to gain insight into the required enabling capabilities. The following results represent observations garnered from FBE-Alfa (September 1997) through FBE-Golf (April 2000). TCT prosecution has been a feature of each FBE. An original fires concept known as “Ring of Fire” has evolved into Poseidon’s Fury, which focuses

on applying the NCO principles of decentralization, Effects Based Operations (EBO), and self-synchronization to targeting both deliberate and time sensitive targets.

The experiments have been conducted with a total-systems perspective. Complete systems of processes, people, information, and things have been tested, in various configurations. One of the greatest values has been the ability to gather information on human interactions within these processes. In TCSF it is important for the “system” to not only be able to react rapidly but to adapt to changing circumstances. The human operators in FBEs have many times adapted to needs for new C2 processes and methods for utilization of new systems.

The results presented here are segmented into four of the essential operational elements that have been tested: Sensor System, Weapon System, Information System, and Command and Control System including human factors.

4.5.1 Sensor System

For the operations concepts tested in FBEs, dominant battlespace awareness and the ability to act on that awareness quickly, accurately, and with decisive force are crucial to success. It all begins with the sensors. The following addresses the total sensor system, from the sensor to the passing of the firing solution to the weapons system, including sensor control, information processing, and information dissemination.

4.5.1.1 Centralized Management of Sensors

FBEs have been carried out with numbers of sensors that are insufficient to achieve complete and continuous coverage of the battlespace. Management of sensor positions and assignments has been a necessary process. Centralized management through an ISR desk has been shown to work well. Centralized management can create bottlenecks, unless a methodology is developed to distribute the mensuration process.

It is necessary to fuse information from strategic, operational, and tactical sensors. Success depends on the ability to coordinate management of organic and non-organic sensors, and tactical input to National Assets sensor management. A wide variety of sensors contribute to constructing the battlespace picture. Mobile targets require additional sensors including an organic MTI/SAR capability. It is difficult to have the needed fusion capabilities exist on all weapon platforms, which means that some centralized processing must be done.

4.5.1.2 Coordinated Management of Sensors

It has been shown that platforms can efficiently prosecute targets when they have organic sensor capabilities. This works well when the platform has a well-defined AOR and a target priority list that is fairly static. In a dynamic situation, it is necessary for platforms to share sensor information, or to share firing solutions. All platforms having sufficient organic sensors and processing capability to carry out their mission independently is impractical. Experimentation has demonstrated that achieving the required detection to engagement times for TCTs requires considerable and rapid coordination among platforms and levels of command. A sophisticated information system is needed to support this level of coordination.

Tactical sensors are required for TCSF. Ships employing land attack weapons such as ERGM or LASM must have an organic capability to target those weapons.

TTPs are needed for sensor control that are responsive to the dynamic tactical situation. It is unclear how control of sensors should change in a self-synchronized manner as tactical requirements change.

4.5.1.3 Distribution of Sensor Information

Sensor management results demonstrate that a mix of centralized and distributed capabilities are needed. This requires that a considerable amount of sensor information be shared. Both raw and processed information need to be distributed. The efficient way to do this is through creation of a sensor information system residing within the common operations picture (COP).

Results indicate that fairly detailed specific sensor information is needed in this information system, such as sensor status, sensor footprint, remaining loiter time, immediate future trajectory, and assignment.

With sufficient bandwidth, it would be possible to distribute imagery on this system. Current capabilities restrict the amount of imagery that can be passed so that passing hyperlinks to imagery locations will be required in the near term. Who gets what information will depend on the function of a node on the system and its available bandwidth.

The structure of the sensor COP must be closely coupled to the structure of the sensor processing and TCSF C2 system.

4.5.1.4 Information Processing Efficiency

Processing of sensor information is time consuming. This is especially true when a target solution is being developed for a weapon-target pair that requires a small Target Location Error (TLE). Time can be saved if a less restrictive TLE is used. Processing for a specific weapon-target pair may allow a less restrictive TLE to be used, saving processing time. On the other hand, delaying the mensuration process until the pairing is decided makes the process more serial whereas parallel processing saves time. Details of how this portion of the targeting process should be coordinated are not yet understood.

FBE-Foxtrot showed that TARPS-CD needed to have multi-spectral capability. Also shown was that target folders need better reference imagery in order for required mensuration to be accomplished. At times, aim points within the required TLE cannot be accomplished but the engagement is needed regardless, hence the desire for barrage fire. This overall problem leads to the need for flexibility in the sensor information processing system. Part of the solution is to have sensor platforms with multi-sensor capabilities and sensors with a range of capabilities. Then sensor and processing can be matched to the situation.

4.5.1.5 Battle Damage Assessment

BDA is an element of a successful TCSF process and is required for efficient weapon employment. Also, BDA is essential to associating effects between operational and tactical levels. A sensor which remains in an area for BDA is not available to detect and identify new

targets, so there is a natural competition between these aspects of sensor deployment. Inclusion of BDA as an explicit part of tactical and strategic sensor management, including specific priorities for it, requires additional asset management control, and a likely increase in the number of and sophistication of sensors and associated C4I.

4.5.1.6 Search Theory

It is not currently possible to completely monitor the battlespace. A search and detection process based on ASW search theory has been developed and tested. This process shows promise for efficient use of available sensor assets when combined with terrain delimitation models.

4.5.1.7 Sensor Coverage

Sensors reveal the changing enemy situation and intentions. Continuous and expansive sensor coverage of the battlespace will minimize potential gaps in critical information. Sensors at the operational level assist information collection necessary to link tactical actions to strategic objectives. The CJTF must totally rely on sensors to maintain the level of situational understanding necessary to visualize multiple interrelated events. These events will provide maximum stress on the C4IR system when they occur simultaneously throughout the battlespace. Sensors will provide the commander with the requisite situational awareness required to implement a plan linking related tactical actions.

4.5.1.8 Weapon-Sensor Pairing

In TCT prosecution, management of sensors is the most critical and difficult challenge in TCSF. Sensor planning and dynamic pairing of sensors to targets must be managed in a manner similar to the way that weapons are apportioned, allocated and paired today. Tactical decision aids should be developed to support sensor planning and execution.

4.5.1.9 Competition for Sensors

Competition for sensors at the tactical level is a serious problem. Two ways to handle this problem are: 1. assign needed sensors to each tactical node for local use, 2. utilize a very capable centralized ISR desk for sensor management. Both solutions require many more sensors than are in the inventory or planned. It is not possible to move a small number of sensors rapidly enough (mobility) to obtain the required TCT information. Centralized management works best for assessing tradeoffs to apply Commanders Intent over the whole battlespace, however it applies great stress on decision making at a single node.

4.5.2 Weapon System

4.5.2.1 Weapon system range, speed, accuracy, and numbers

TCSF requires a mix of weapons to engage the large numbers and types of expected targets. Also, Navy fires will be responsible for full battlespace coverage early in an engagement, and this can include targets far inland. There are existing or planned weapons which meet all requirement types. However, the inventory of weapons is not sufficient to conduct extensive or target-rich operations. Careful consideration needs to be given to the weapon mix characteristics: speed, accuracy, range, numbers. These need to be balanced to provide an overall capability to conduct expected operations.

4.5.2.2 Naval Surface Fires

Naval Surface Fires weapons such as conventional 5 inch, ERGM, and LASM are of limited utility for engaging TCTs in urban areas. Relatively depressed trajectory and accuracy limitations often results in reticence by commanders to employ these fires for fear of collateral damage.

4.5.2.3 Loitering Weapons

Loitering weapons such as the Tactical Tomahawk Land Attack Missile (TTLAM) can be key assets for engaging high value TCTs. However, the actual and opportunity costs of the TTLAM when compared with the target and the availability of alternative solutions limit its actual use in logistically constrained environments. Doctrine and Tactics, Techniques, and Procedures need to be established governing the employment of this weapon.

4.5.2.3 Suppression of enemy targets.

While Precision Guided Munitions (PGM) are an essential component of TCSF, they do not meet the full range of engagement requirements. TCSF requires an area fire weapon that can be employed for quick reaction fires or when Target Location Error (TLE) exceeds established guidelines for the various PGMs.

Suppressive fires are applicable to high priority, short-dwell time targets. It may not be feasible to obtain quickly enough an accurately mensurated target position for a short dwell-time target. With current processes it is difficult to engage a target in less than 30 minutes, which is insufficient for many situations. Firing a pattern of low Pk area weapons at the unmensurated target position in order to suppress the target has been shown to be effective.

4.5.3 Sensor – Target – Weapon Compatibility

4.5.3.1 System Interdependencies

The information needed to support TCT targeting and weapon assignment depends upon the combination of target type and weapon type that are being paired. There are interdependencies between all of the factors:

- Sensor capabilities
- Target type, including dwell time
- Sensor information processing
- Weapon characteristics
- Weapon platform location and system status

There is a complex set of interactions that leads to many possible solutions for a given target. A given solution has been referred to as a thread. It is not necessary to locate an optimal thread. It is necessary to identify a thread that satisfies the requirements for that target. Coordination between sensor system management and weapon system management must support identifying and choosing between these threads. It is more important to be able to quickly make a feasible pairing with the information in hand than to wait for all information on which to base an optimal choice.

4.5.3.2 Predetermined Pairing Solutions versus Flexibility

In a network centric TCSF a trigger event creates numerous potential engagement alternatives and the traditional Detect to Engage (DTE) process becomes a complex sensor-target production-engagement-BDA linkage. Attempts to rigidly define an end-to-end process or predetermined “engagement thread” have not been successful. What is required is the interoperability, information access, and organizational flexibility to allow the operators to adapt the DTE process in the most effective manner.

During FBEs, operators have developed general DTE patterns for different types of sensor events, targets, latency requirements etc. These patterns are however, contextual and will change with the operational situation. Resource competition occurs where these patterns intersect. To date the most intense competition has occurred over sensor control and target mensuration. A networked environment where bandwidth supports reachback and distribution of tasks has appeared to be the most effective resolution to these conflicts.

4.5.3.3 Tactical Decision Aids

The inability to rigidly define DTE processes has seemingly limited the effectiveness of Tactical Decision Aids (TDA) such as the weapons-target pairing algorithms found in the Land Attack Warfare System (LAWS) or the Joint Continuous Strike Environment (JCSE). However, if TDAs are designed as aids to the operator vice an automated substitute for individual judgement and knowledge of the commander’s intent, then they may yet play a key role in TCSF.

Increasingly complex TDAs may not be the answer. As a TDA increases in complexity it becomes difficult for the operator to know what is, and is not, included in the aids processing. Experiments to date have shown that it is essential to know what is “under the hood”, as well as the intentions of the commander, in order to effectively conduct TCSF.

4.5.4 Information System

4.5.4.1 Bandwidth

Results in all experiments indicate that bandwidth is a critical enabler. As the C2 structure is flattened, increasing amounts of information have to be passed between distributed nodes. TCT introduces the need for drastically increased speed. Efficient use of bandwidth is desirable, but it should be recognized that increased bandwidth should continue to be acquired however possible.

It is not possible to narrowly define the information requirements or process involved in TCSF. For example, when it made sense in the operational context, operators have mensurated similar targets locally, reached around the theater for assistance, or reached back to CONUS. Network Centric Operations relies on the nodes as intelligent, complex adaptive systems and these systems must have the flexibility to adapt the network. Bandwidth is the key to making this adaptation possible.

Reachback to CONUS for support is a required capability but execution functions must remain in theater. Reachback is necessary to decision aids such as those provided by the Defense Threat

Reduction Agency (DTRA) and the Joint Warfare Analysis Center (JWAC), or for targeting services such as those provided by the Cruise Missile Support Activity (CMSA). Determining the tradeoff between the bandwidth required for reachback vice employing technical solutions forward, is a key question.

4.5.4.2 COP, CTP, or CROP

A considerable amount of work has gone into providing a common backbone of information and display of common information to the operation. Most of the effort has gone into operational situational awareness information, the Common Operational Picture. Lessons learned are making it apparent that a common information database is required but that not all operators need or should have the same picture. CROP refers to providing only the information that is Relevant to a particular task. One distinction between the Operational and Tactical pictures is that the Tactical requires a very high refresh rate, and a scheme is needed to do this without overloading the information systems or clogging communications.

Providing only Relevant information appears to have some dangers. It could interfere with developing shared situational awareness between operators in different functional areas. How to provide what information in what format to whom is a subject of intense investigation.

4.5.4.3 Data Transfer Between Elements of the TCT System

The proper operation of the TCT system is critically dependent on the efficient flow of information between the various elements of the system: sensor imagery to GISRS, target nominations from GISRS to LAWS and JTW, mensuration from JTW to LAWS, route requests for TLAM missions from LAWS to RPM, the route from RPM to LAWS and the shooter, the LAWS weapon-target pairing to all approval nodes, the fire command from LAWS to the shooter, BDA imagery from the sensor to GISRS, etc.

The efficient flow of these data requires that the processes be as automated as possible with the need for human intervention minimized. During execution, valuable time has been wasted in determining if target mensuration data were available. There was no quick, reliable means of announcing to concerned participants that a target mensuration had been completed and the data is available. The efficient exchange of information also requires that the communications links be robust and of adequate bandwidth to bear the anticipated traffic.

4.5.4.4 Cradle-to-Grave Target Information

Sensor management requires full knowledge of targets from initial detection through BDA. Sensors must be assigned for BDA, which means that the target must remain in the COP until final BDA is accomplished. If this is not done, sensors that are appropriate for a BDA assignment will be pulled to other activities.

4.5.4.5 Sensor Information

Sensor information supplied to a sensor manager does not currently include all of the information needed for sensor management. Sensor management requires not only current locations but also planned trajectories, current assignment, ground coverage, planned future assignments, and remaining air time.

4.5.4.6 Weapon Information

Weapon information is required for sensor management. A dynamic system is needed that makes visible weapon availability and shows possible weapon-target pairing and progress status as an input for sensor assignment. This will allow the sensor manager to make the correct choice of sensor for the required TLE.

4.5.4.7 Digital Target Folders

The Digital Target Folder (DTF) is emerging as the vehicle selected to be the repository for all information collected on a target. Experience has generated the following lessons:

1. All data must be entered into the DTF automatically. The data target nomination sent to the DTF was entered manually. This time consuming process is a significant impediment to a timely TCT process.
2. The DTF must be designed to accept all data. For example, the DTF in FBE G would only record a single target mensuration position. If the target is mensurated multiple times all the mensuration data should be presented.
3. All data in the DTF must be time tagged so that the user can properly evaluate it.
4. The DTF must be accessible at a single keystroke. A cumbersome process of accessing the web site burdens overstressed operators.
5. It would be desirable to automatically communicate to users when a DTF has been updated and with what data.

4.5.4.8 Graceful Degradation.

The TCT process will be designed as an optimized system. But the optimum environment for the system cannot be expected to be maintained, particularly under combat conditions. It is essential that the system be designed to degrade gracefully. As systems fail, or links are lost, the TCT must continue to function though with reduced capability. A system must not fail catastrophically.

An interesting, and unanticipated, result of FBEs is the efficiency with which the human operators in the experiments develop work-arounds when systems fail. It appears that a component of graceful degradation is to design the systems with flexibility that enables the humans in the loop to reconfigure as best suits their needs. System or process revisions must be made known to all participants or confusion results.

4.5.4.9 Decision Tools

LAWS has been employed in all FBEs to furnish weapon target pairings. As used in the FBEs to date, LAWS simply presents the engagement cell with a list of weapon options. LAWS has or will soon have the capability of selecting the optimum weapon for the target. LAWS has proved to be an invaluable tool in the TCT process. There is a need for a similar tool to manage the sensor-target pairing both in the target acquisition and BDA phases of the TCT process. It must be recognized that such tools can be large consumers of bandwidth.

The COP, or perhaps eventually a CTP, is the backbone of information for an operation, but it is also useful to think in terms of it as providing important background information for targeting decisions. Because of its wider perspective, it can enable additional identification information (launch of a missile for example). It can provide an understanding of the location and status of

friendly units which might provide targeting quality information for fires, BDA, the potential for fratricide and collateral damage, downwind fall-out casualties, etc. Before engagement, the COP can provide significant help in collection management prioritization and interpretation for IPB. It can serve as a way to pass important sectorization decisions and serve as one basis for collaborative planning.

4.5.4.10 Blue weapons status and position as part of the CTP.

Overall situational awareness requires the status of our weapon systems. This could be disseminated by the CTP. This includes magazine status, tube load-out, weapon status, locations, time to target, etc. This level of information is needed at many decision nodes because of the extremely short latencies, very accurate location, and firm identification of TCTs. Inclusion of such information in the CTP should be done in a readily accessible sub-layer to avoid operator information overload.

4.5.5 Command and Control System

4.5.5.1 Flattening the Command and Control Structure

Flattening the C2 structure has demonstrated the capability to reduce the TCT timeline. Such reduction depends on several factors, including shared situational awareness, rapid communications, information control and distribution, and commander's confidence in the process.

A flattened C2 architecture must be adaptable to the situation. During some phases of an operation, such as pre-hostilities or when there are complicating factors such as an increased risk of collateral damage, Commanders will exert increased control. Organizations must be adaptable and flexible enough to accommodate varying degrees of centralization.

Flattening requires that weapons firing platforms have the ability to immediately engage when targeting requirements are met. Procedural deconfliction as currently practiced will not support TCSF. While this is possible in a segregated battlespace that creates TCT free fire zones it is not practical in congested littoral areas where platforms, sensors and weapons must operate in the same battlespace. A method of dynamic 4-dimensional deconfliction must be developed.

4.5.5.2 Collaborative Planning and Decision Tools

It has been demonstrated that face-to-face interactions are important for both planning and tactical execution. Flattening the C2 structure tends to separate decision-makers who must coordinate. Collaborative planning and execution tools are required to facilitate execution within a flattened C2 architecture. The tools and the rule sets for their use must replicate the face-to-face interactions.

The introduction of Distributed Collaborative Planning (DCP) tools will not automatically result in improved planning or execution. Without developing appropriate relationships and protocols regarding the use of the tools, DCP will hinder situational awareness and cause commander's to centralize operations at the expense of speed. Also, care must be taken in designing a DCP

system, including all needed interactions while recognizing that increasing the number of nodes will increase the time to take action.

Management of collaborative, deliberate planning and of execution are fundamentally different. Collaborative development of deliberate plans will be typified by formal relationships, ordered processes and will be generally marked by a low level of innovation. On the other hand collaborative execution requires that relationships be tacitly understood and that processes retain the flexibility to adapt to a constantly changing operational environment. Collaboration in execution will be highly innovative. This complicates development of appropriate TDAs.

4.5.5.3 Joint Fires Element and Effects Based Operations

A Joint Fires Element (JFE), which includes all aspects of the Fires process, has been examined. A goal was to test a process that included planning and execution for effects. The experiment revealed that there is insufficient monitoring of a wide range of effects and no effective feedback means for passing such information to the JFE for real-time execution. It was also revealed that a means is needed to produce dynamic Commander's Intent on the same time scale as effects occur during tactical execution.

4.5.5.4 Commander's Confidence

Commanders will not permit decentralized operations unless they have confidence that the operational nodes understand both what is expected and what is forbidden. Likewise command by negation within a distributed architecture is only possible if the commander has situational awareness and confidence in his or her operational picture. Tools, which support situational awareness, such as the Global Command and Control System (GCCS), must support the requirement of the commander to develop confidence as well as the information needs of the various operators. Confidence in the ability of subordinate commanders to take independent action in a flattened C2 structure is developed only through experience. A subtle point is that the commander must also have confidence that automated information distribution systems provide needed information to subordinate commanders and that they have a team that knows how to assess that information.

4.5.5.5 Commander's Intent

The goals, the effects to be achieved, during an operation must be set from the top of the command structure. A flattened C2 structure has less face-to-face interaction, which places demands on clear articulation of intent and providing more detail than is normally the case. In a TCT environment the tactical situation can change rapidly, which can necessitate modification of Commander's intent. Feedback at the needed rate is a required part of this process. The C2I system must be designed to allow this to be done.

4.5.5.6 Navy Organization

Existing Navy organizations and processes do not adequately support anticipated use of future Navy weapons capabilities such as Extended Range Guided Munition (ERGM), Land Attack Missiles, and Joint Stand Off Weapon (JSOW) to support land forces. In order to effectively apply precision fires in support of the access requirements of maritime forces, the Navy must develop the ability to generate deliberate targeting and TCS guidance, apportion TACAIR and other Navy fires, and develop targets. The organization and process need not mirror existing

joint organizations such as a JFACC and Combined Air Operations Cell (CAOC) but must be capable of performing the key functions and should be adaptable to joint organizations as the theater matures.

4.5.5.6 Targeting Function

The targeting function for TCT, in order to provide identification and short latency, will need to have imagery support directly from the sensors and a close degree of sensor platform control of the sensor. They must also have very tight connection to fires. But for effects based prioritization, re-tasking of strike platforms, and deconfliction, the targeting net must include a node with broad understanding of the current status of the operations and with authority not only to direct fires but to re-task platforms that are performing lower priority missions. This must be a fairly powerful node with quick access to responsible command levels. It must be supported by a good CTP as well as the much more restricted targeting nets and have extensive intelligence support from national sources, probably through a Joint Intelligence center. In large-scale joint or coalition operation, this node will have to be at the JTF-level and have the commanders personal blessing because of the necessity of intervening in on-going missions in order to respond to TCT as well as high priority for intelligence collection and sensor management.

4.5.5.7 People and Positions

Unit manning (based on traditional ratings, ranks, NECs) and organization is optimized for hierarchical operations in a pre-information age. The prospect of Network Centric Operations aboard minimally manned ships in the contested littorals, calls for a wholesale reassessment of the skill required by operators and of the organizations used to focus those skills. Execution of Time Critical Strike and Fires requires operators with an advanced knowledge of weapons and sensor capabilities and an intuitive knowledge of operations on land. The complexity of the littoral environment and the increased responsibility given to operators in a flattened C2 architecture will require operators with new skill sets. Developing these skills and retaining these highly skilled personnel will be a key challenge for the future Navy.

Information Management has emerged as a crucial factor in FBEs. Reliability, latency, validity, distribution, relevancy to the task, are all factors that affect operations. Methodologies, such as the COP, and the hardware and software tools, for managing information are being developed. Experimentation has revealed new positions that are needed. Four generic position types that have been identified are

Sensor Manager

Network Manager

Information Manager

COP Manager

How such positions fit into staffs needs to be determined and a developing program of training the human skills to perform these jobs is needed.



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